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## Results of the Puritan-American Museum of Natural History Expedition to Western Mexico

### 5. Pliocene and Pleistocene Megafossils from the Tres Marias Islands

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#### INTRODUCTION

Metazoan invertebrates of Pliocene and Pleistocene age were collected by the junior author from María Madre and María Cleofas Islands during the expedition's visit to the Tres Marias Islands, March 23 to April 7, 1957 (see Emerson, 1958, for the itinerary). Although few species are represented in the collections, the occurrence of fossiliferous sediments on María Cleofas Island, the most southeasterly of this insular group, is recorded here for the first time. Brief notes on the stratigraphy and on a few lithologic specimens are also included.

In order to give a more complete presentation of the Pliocene paleontology of these islands, the megafossils cited by Jordan and Hertlein (1926a) from María Madre Island are included in the present faunal list, and the nomenclature of the previously reported species has been brought up to date. Late Pleistocene fossils from María Cleofas Island are listed, with remarks on the paleogeographic significance of the assemblage. The present expedition's collections from María Madre

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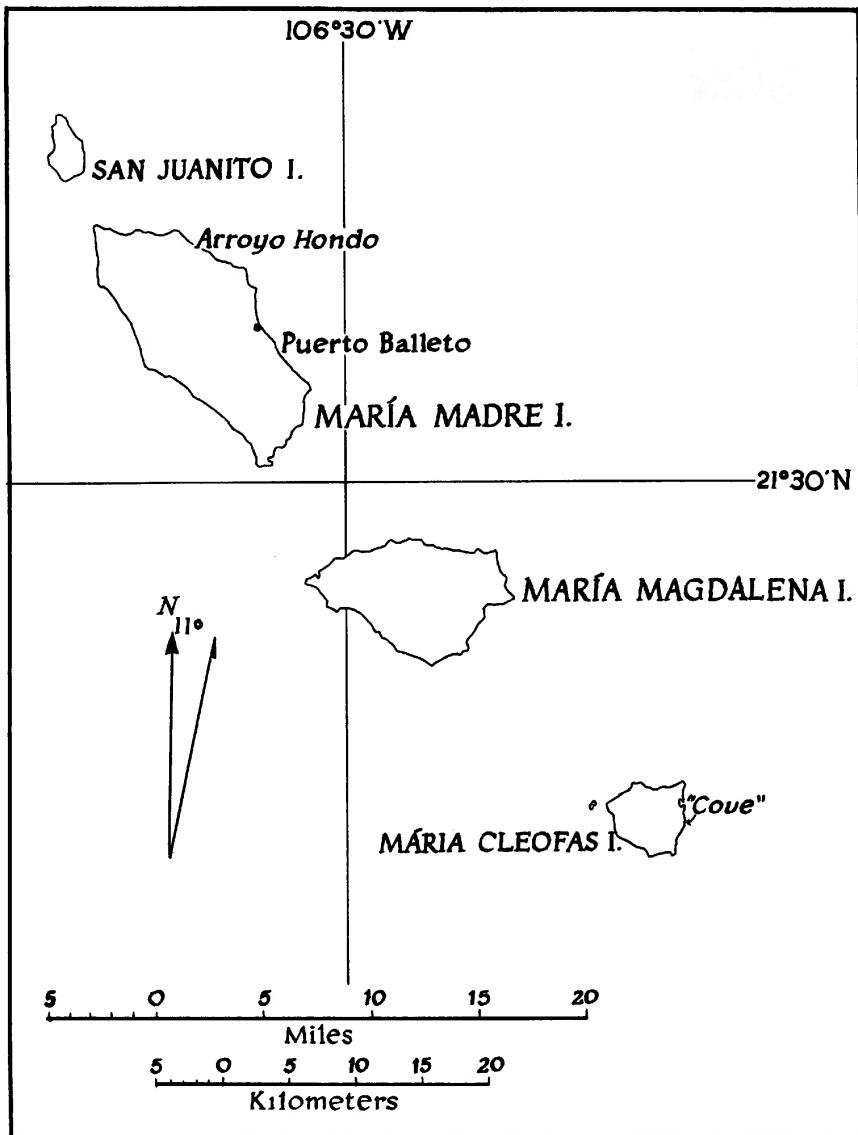


FIG. 1. Chart of the Tres Marias Islands, showing the general location of the principal collecting stations mentioned in the text. "Cove" on the east side of Marí Cleofas refers to localities F-14 to F-18. (Base after United States Hydrographic chart no. 622.)

Island taken from Pleistocene collecting stations previously made by the California Academy of Sciences expedition of 1925 and recorded by Hertlein (1934) are not included in this paper.

#### ACKNOWLEDGMENTS

The writers wish to express their appreciation to Mr. Harry J. Bauer of Los Angeles, California, for providing the means by which the junior author was able to obtain the collections here described. Acknowledgment is due Dr. G. Dallas Hanna, Curator, Department of Geology, California Academy of Sciences, for advice and for information concerning the geology of the Tres Marías Islands; also to Mr. Charles W. Chesterman, geologist, California State Division of Mines, for aid in the identification of rock specimens. Mr. Oakes A. Plimpton kindly assisted the junior author in field collecting.

#### BRIEF REVIEW OF THE LITERATURE

The four islands of the Tres Marías Group lie about 55 to 60 miles off the west coast of Mexico, north of San Blas, Nayarit, and about 200 miles southeast of Cape San Lucas, Baja California, between latitudes 21° and 22° N., longitudes 106° and 107° W. (see fig. 1).

The first Spaniards said to have had knowledge of the existence of the Tres Marías Islands were soldiers of Francisco Cortés in 1524 (Martinez, 1956, p. 80, footnote 4), but the actual discovery of the islands is attributed to Diego Hurtado de Mendoza, in 1532 (Martinez, 1956, p. 80; Medina, 1957, p. 32).

Despite the early discovery of the Tres Marías, very little of the details of the geology or paleontology was known until 1926 when papers resulting from the expedition of the California Academy of Sciences to those islands were published. In the general report of the expedition, Hanna (1926) gave a brief description of María Madre Island and of María Magdalena Island, including a general account of the geology. However, the occurrence of marine fossils on María Madre Island was first mentioned by Grayson (1872, p. 266) and later by Nelson (1899a, p. 10).

Collections resulting from the California Academy of Sciences expedition of 1925 formed a basis for several scientific reports, including one by Hanna and Grant (1926) containing a description of the diatoms occurring in the Miocene diatomite on María Madre Island and another by Jordan and Hertlein (1926a) dealing with Pliocene megafossils from that island. Pleistocene mollusks from María Madre Island

and María Magdalena Island were listed, and their significance was discussed, by Hertlein (1934).

Two important papers dealing with the Recent mollusks of the Tres Marias have been published. One by Stearns appeared in 1894 and one by Strong and Hanna was published in 1930.

The general features of this island group of particular interest to navigators can be found in Publication 84 of the United States Hydrographic Office.

### ROCK SAMPLES

Samples of rocks were collected by the junior author at five localities on two of the islands. A megascopic examination of these was made by the senior author and by Mr. Charles W. Chesterman of the California State Division of Mines.

The rock types represented and the localities from which they came follow:

1. Igneous rock from head of an arroyo on the southeast side of María Magdalena Island, elevation approximately 100 feet: ?Andesite.
2. Outcrop exposed in the intertidal zone; southeast side of María Magdalena Island, latitude  $21^{\circ} 25' 30''$  N., longitude  $106^{\circ} 23' 45''$  W.: Shale.
3. Rock in place near upper end of Arroyo Hondo, María Madre Island: Basalt.
4. Float in stream bed of Arroyo Hondo, María Madre Island: Basalt; quartz diorite; quartzite.
5. Exposure in road cut about halfway between Puerto Balleto and Arroyo Hondo, María Madre Island: Quartz.

### PLIOCENE FAUNA

#### MARÍA MADRE ISLAND

The general geology of María Madre Island was stated by Hanna (1926) to consist of a central core of granitic rocks. Lying upon these are beds of diatomite, approximately 1000 feet in thickness, of Miocene age, which in turn are unconformably overlain by strata of Pliocene age attaining a thickness of 300 to 500 feet. The Pliocene beds, with a dip of about 15 degrees, are inclined away from the central mass. At certain places near the coast the Pliocene rocks are unconformably overlain by beds containing fossils of Pleistocene age (see fig. 2).

The Pliocene strata are composed of loosely consolidated calcareous material accompanied by coarse sand and pebbles (Hanna, 1926, p. 69). Blocks of reef coral were reported by Jordan and Hertlein (1926a, p. 210) to be irregularly distributed in the formation. Many megafossil pelecypods, especially pectens, of which *Pecten abietis* is the most

abundant, the previously mentioned species of hermatypic coral, a brachiopod, and abundant Foraminifera occur in these strata. The general character of the sediment and the enclosed fossils, as mentioned by Jordan and Hertlein, indicates that they were deposited in warm, shallow water, in part perhaps in the littoral zone.



FIG. 2. Bluff on the north side of the entrance of Arroyo Hondo from which Pliocene megafossils were collected.

Collections of fossils of Pliocene age were secured by the present expedition at two localities on María Madre Island. These were from bluffs exposed at the mouth of Arroyo Hondo in the same general locality as localities 937 and 938 (California Academy of Sciences) from which fossils were recorded by Jordan and Hertlein (1926a).

#### MARÍA CLEOFAS ISLAND

Collections of fossils of Pliocene age were assembled from two locali-

ties in the center of a small cove on María Cleofas Island (fig. 3; and Emerson, 1958, fig. 8). These fossils (as well as those of Pleistocene age) are of especial interest in that they represent the first record of fossiliferous deposits from this island of the Tres Marias Group.

The number of species in these collections is only six (one identified only as to genus), but the pectens with two exceptions also occur on



FIG. 3. South headlands of the "cove" on the east side of María Cleofas Island, Pliocene locality F-14.

María Madre Island. The stratigraphic occurrences as well as lithologic character of the strata are so similar to those on María Madre Island that they suggest approximately contemporaneous deposition.

Collecting stations from which Pliocene fossils have been obtained on the Tres Marias Islands are as follows:

#### THE AMERICAN MUSEUM OF NATURAL HISTORY LOCALITIES

- F-14: Southern headlands of a small cove on the east side near the center of María Cleofas Island (see fig. 3).
- F-16: Northern headlands of cove at localities 14 and 15.
- F-19: Bluff forming south bank at mouth of Arroyo Hondo, María Madre Island.
- F-21: Same as at locality F-19, but at beach cliffs 100-200 yards north of the mouth of Arroyo Hondo at an estimated elevation of about  $100 \pm$  feet, María Madre Island (see fig. 2).

## CALIFORNIA ACADEMY OF SCIENCES LOCALITIES

937: María Madre Island, Tres Marías, Arroyo Hondo, near northeast corner of island: First exposure in stream bed upstream from mouth.

938: María Madre Island, Tres Marías: Beach cliffs 200 yards south of mouth of Arroyo Hondo; dark gray shales.

939: María Madre Island, Tres Marías: Cliffs about 1 mile south of and above village.

940: María Madre Island, Tres Marías: Lighthouse Point on shore about 1 mile southeast of village.

941: María Madre Island, Tres Marías: Float in arroyo,  $\frac{3}{4}$  mile north of village.

942: María Madre Island, Tres Marías: Miscellaneous collections from Pliocene.

## AGE AND CORRELATION

The list of species represented in the present collections from María Madre Island and María Cleofas Island, combined with those cited by Jordan and Hertlein (1926a) from María Madre Island, contains 20 species (see table 1). In addition, one genus, *Spondylus*, is recorded from María Cleofas Island, but the preservation is such as to preclude specific identification.

Six forms are here recorded from María Cleofas Island, three of which have not been found on María Madre Island. However, the species in common, as well as the character of the lithology and the stratigraphic position of the beds on the two islands, suggest that they represent approximately contemporary deposition.

The hermatypic coral was identified by the late E. H. Quayle as *Siderastrea mendenhalli minor* Vaughan (1917, p. 375, pl. 102, fig. 1), by J. W. Durham as *Solenastrea* cf. *S. fairbanksi* Vaughan (1917, p. 372, pl. 95, figs. 3, 3a), and by D. F. Squires as *Solenastrea fairbanksi* var. *minor* Vaughan (1917, p. 373, pl. 97, figs. 2, 2a-c), all of which forms were originally described from Imperial County, California, in beds generally considered to be of Pliocene age and by some workers as of early Pliocene age.<sup>1</sup> The specimens of coral here cited from María Madre Island were found loose in the bed of Arroyo Hondo on María Madre Island. According to Hanna (verbal communication), the beds in that area are of Pliocene age, and, according to the field observations of Hanna and Jordan, blocks of coral occur in those beds.

<sup>1</sup> According to Vaughan and Wells (1943, p. 174), representatives of the genus *Solenastrea* are known from the Oligocene and Miocene of Europe and Asia Minor and from the Miocene to the present time in the West Indies and Florida. These authors, therefore, included the corals of the Imperial formation in the Caribbean faunal province and apparently were not aware of the occurrence of *Solenastrea* in the Pliocene of the Tres Marías Islands.

TABLE 1  
LIST OF PLIOCENE SPECIES

	A.M.N.H. Localities						C.A.S. Localities				
	Maria	Cleofas	Maria	Madre			938	939	940	941	942
	F-14	F-16	F-19	F-21							
<i>ANTHOZOA</i>											
<i>Solenastrea fairbanksi</i> var. <i>minor</i> Vaughan	—	—	—	—	—	—	—	—	—	<i>x<sup>a</sup></i>	—
<i>BRACHIOPODA</i>											
<i>Terebratula</i> cf. <i>T. jordanii</i> Hertlein and Grant	—	—	—	—	—	—	—	—	—	<i>x<sup>b</sup></i>	—
<i>Nuculana</i> cf. <i>N. callimene</i> Dall	—	—	—	—	—	—	<i>x<sup>c</sup></i>	—	—	—	—
<i>Ostrea angelica</i> Rochebrune	—	—	—	—	—	—	<i>x<sup>d</sup></i>	—	—	—	<i>x<sup>d</sup></i>
<i>Ostrea conchaphila</i> Carpenter	—	—	—	—	—	—	—	<i>x</i>	<i>x</i>	—	—
<i>Ostrea corteziana</i> Hertlein	—	—	—	—	—	—	—	<i>x<sup>e</sup></i>	<i>x<sup>e</sup></i>	—	—
<i>Ostrea</i> cf. <i>O. erici</i> Hertlein	—	—	—	—	—	—	—	<i>x<sup>e</sup></i>	—	—	—
<i>Ostrea megodon</i> Hanley	—	—	<i>x</i>	—	—	—	—	<i>x</i>	—	—	<i>x</i>
<i>Ostrea vespertina veitchii</i> Gabb	—	—	<i>x</i>	—	—	—	<i>x<sup>f</sup></i>	—	—	—	—
<i>Pecten (Argopecten) abealis</i> Jordan and Hertlein	<i>x</i>	—	<i>x</i>	<i>x</i>	—	—	<i>x<sup>g</sup></i>	—	—	—	<i>x<sup>g</sup></i>
<i>Pecten (Argopecten)</i> cf. <i>P. (A.) circularis</i> <i>circularis</i>	—	—	—	—	—	—	<i>x<sup>h</sup></i>	—	—	—	—
Sowerby	—	—	—	—	—	—	—	—	—	—	—
<i>Pecten (Argopecten) circularis calli</i> Hertlein	<i>x</i>	—	—	—	—	—	—	—	—	—	—
<i>Pecten (Chlamys) dallazi</i> Jordan and Hertlein	—	—	<i>x</i>	—	—	—	<i>x</i>	—	—	—	—
<i>Pecten (Nodipecten) subnodosus</i> Sowerby	cf.	—	—	—	—	—	cf.	<i>x</i>	—	<i>x</i>	—

TABLE 1—Continued

	A.M.N.H. Localities				C.A.S. Localities			
	Maria	Cleofas	Maria	Madre	Maria	Madre	940	941
	F-14	F-16	F-19	F-21	937	938	939	942
<i>Pecten (Patinopecten)</i> cf. <i>P. bakeri diazi</i> Durham	—	—	—	—	—	x <sup>a</sup>	—	—
<i>Pecten (Patinopecten)</i> cf. <i>P. bakeri marquerensis</i> Durham	cf.	—	?	—	—	x <sup>b</sup>	—	—
<i>Pecten (Pecten) vogdesi</i> Arnold	—	x	—	—	—	—	—	—
<i>Pecten (Pecten) stevensii</i> Dall	—	—	—	x	—	—	—	—
<i>Placunatoma cumingii</i> Broderip	—	—	?	—	—	x	—	x
<i>Spondylus</i> sp.	x	—	—	—	—	—	—	—
<b>CIRRIPEDIA</b>								
<i>Coronula</i> cf. <i>C. diadema limmaeus</i>	—	—	—	—	x	—	—	—

<sup>a</sup> Cited as *Solenastrea* sp. by Jordan and Hertlein (1926a).

<sup>b</sup> Cited as *Terebratula* sp. by Jordan and Hertlein (1926a).

<sup>c</sup> Cited as *Leda* sp. by Jordan and Hertlein (1926a).

<sup>d</sup> Cited as *Ostrea cumingiana* Dunker by Jordan and Hertlein (1926a).

<sup>e</sup> Cited in part as *Ostrea chilensis* Philippi by Jordan and Hertlein (1926a).

<sup>f</sup> Cited as *Ostrea vespertina* Conrad by Jordan and Hertlein (1926a).

<sup>g</sup> Cited as *Pecten (Plaioctenium) invalidus* Hanna by Jordan and Hertlein (1926a).

<sup>h</sup> Cited as *Pecten (Plaioctenium) circularis* Sowerby by Jordan and Hertlein (1926a).

<sup>i</sup> Cited in part as *Pecten (Pecten) stearnsii* Dall by Jordan and Hertlein (1926a).

<sup>j</sup> Cited as *Pecten (Patinopecten) near courtains* Gould by Jordan and Hertlein (1926a).

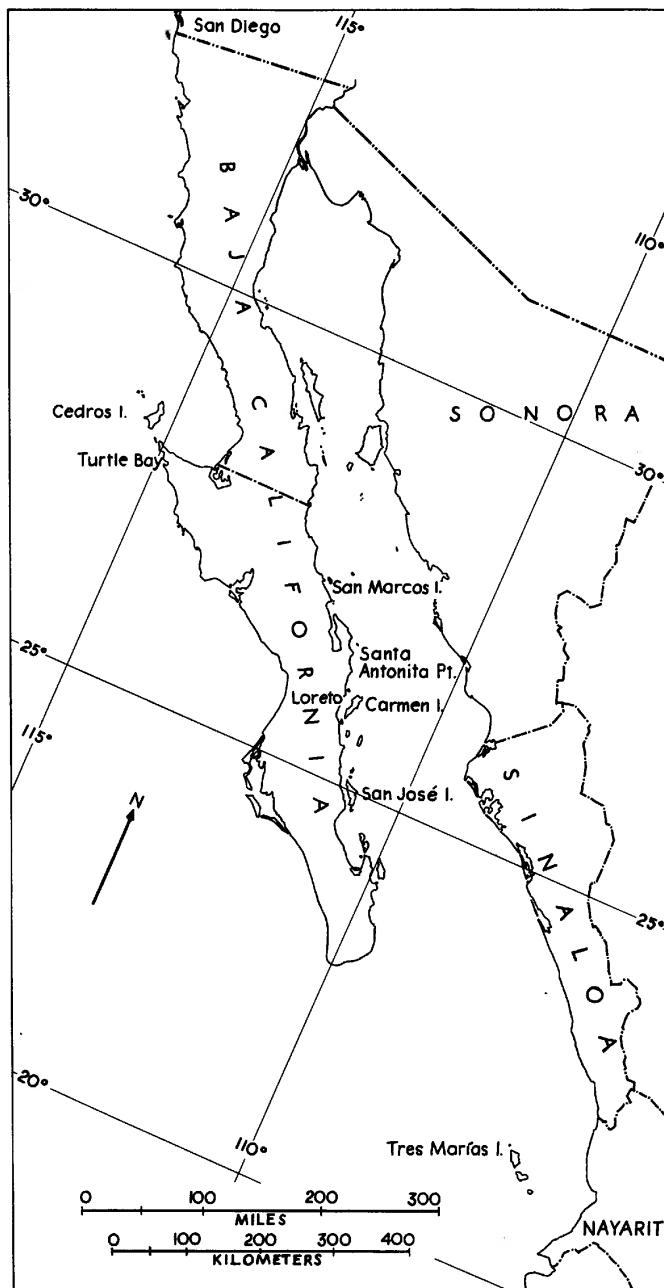


FIG. 4. Map of northwestern Mexico indicating the location of the Pliocene faunas that are mentioned in the text.

The brachiopod *Terebratalia* cf. *T. jordani* Hertlein and Grant closely resembles *T. jordani* which was described from strata of Pliocene age at Punta Santa Antonita, on the east coast of Baja California. At that locality the type specimen occurred in beds containing *Clypeaster bowersi* Weaver, a species that also occurs in beds of Pliocene age in Imperial County, California.

Of the 17 species of pelecypods cited in table 1, nine species are living in tropical west American waters today. Six of the 17 were cited by Durham (1950) as occurring in beds in the Gulf of California region assigned by him to early Pliocene age, eight in the middle Pliocene, and seven in the late Pliocene. He recorded four of the species as ranging through early, middle, and late Pliocene and an equal number as occurring in beds believed to be no older than middle Pliocene. Six species occur in beds of Pliocene age at Cedros Island and Turtle Bay, Baja California, and one occurs in the adjacent region. *Pecten dallasi* and *Ostrea erici* have been recorded only from strata considered to be of middle Pliocene age, and the latter species occurs in beds of that age in San Diego, Los Angeles, and the Santa Maria district, California.

Durham (1950, p. 30) believed the fossils from María Madre Island to be of approximately the same age as those of the Carmen formation, referred by him to the middle Pliocene in the Gulf of California. This view was based primarily on the occurrence of species such as *Pecten dallasi* and *Pecten bakeri diazi* which suggest middle rather than early Pliocene age.<sup>1</sup> This in general bears out the conclusion of Jordan and Hertlein (1926a) concerning the age of the fossils from María Madre Island, who stated that the beds are not far removed in age from the Pliocene strata at Loreto, Santa Antonita Point, and San José Island in the Gulf of California.<sup>2</sup> Furthermore, they stated that the beds on María Madre Island are no older than the Pliocene strata on Cedros Island, Baja California, and the San Diego formation in southern California. The latter formation is generally considered to be of middle Pliocene age.

<sup>1</sup> In his general correlation chart, however, Durham (1950, p. 35) questionably assigns the lower section of the María Madre Island Pliocene deposits to the early Pliocene. This assignment is apparently based on the presence of an "Imperial formation coral" (Durham, p. 30) in the Tres Marias fauna.

<sup>2</sup> The strata on San Marcos Island, also mentioned by Jordan and Hertlein (1926b), were later referred by Durham (1950) chiefly to the early Pliocene, although he also referred to beds of probable middle Pliocene age on that island.

## PLEISTOCENE FAUNA

Fossils of Pleistocene age from María Madre Island and María Magdalena Island were recorded by Hertlein in 1934. The occurrence and composition of the faunas were briefly discussed, and the assemblage was compared with the late Pleistocene fauna of Magdalena Bay, Baja California.

The present collections include small assemblages from terrace deposits on María Madre Island and María Cleofas Island (see fig. 5). Those from the former island are not recorded, as they duplicate records listed previously by Hertlein (1934).

A total of 27 species, chiefly mollusks, was obtained from deposits on the east side of María Cleofas Island. The species are enumerated in

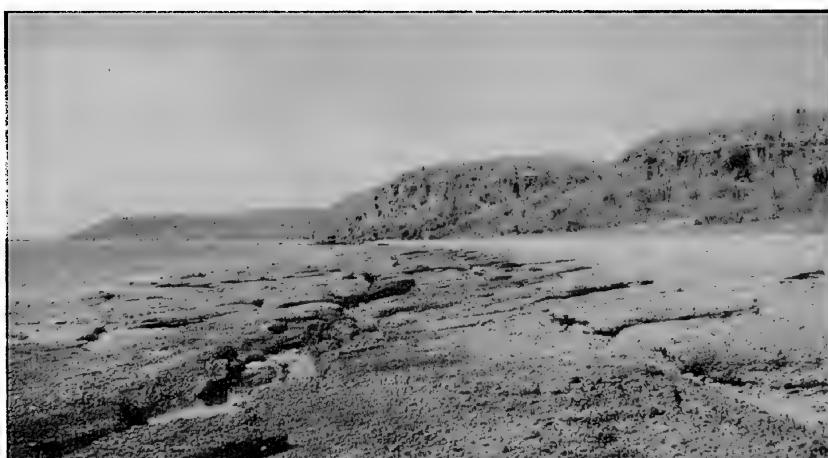


FIG. 5. Terrace deposits on the southeastern end of María Madre Island, near the "salt works," from which Pleistocene megafossils were collected.

table 2. The occurrence of these fossils reveals that this island was submerged along the margins at certain places, indicating a geological history during late Pleistocene time similar to that of María Madre Island and María Magdalena Island.

All the species are now living in the adjacent marine waters, or they are known to have lived in the region of the Gulf of California in late Pleistocene time. There is no reason to believe that conditions at the time of deposition of these beds varied essentially from those prevailing in adjacent waters at the present time.

Collecting stations from which Pleistocene fossils were secured on María Cleofas Island by the expedition are:

Locality F-15: Bluff in about the center of the cove at locality 14, elevation approximately 20 feet.

Locality F-17: Ten to 12 feet of well-cemented, limy, very hard conglomerate overlying beds at locality F-16.

Locality F-18: Just north of locality F-17, sandstone at head of arroyo (a dry wash).

TABLE 2  
LIST OF PLEISTOCENE SPECIES FROM MARÍA CLEOFAS ISLAND

	F-15	F-17	F-18
ANTHOZOA			
<i>Porites californica</i> Verrill <sup>a</sup>	x	—	—
PELECYPODA			
<i>Antigona isocardia</i> Verrill	x	—	—
<i>Apolymetis cognata</i> Pilsbry and Vanatta	x	—	—
<i>Arca multicostata</i> Sowerby	x	x	—
<i>Cardita tricolor</i> Sowerby	x	—	—
<i>Cardium biangulatum</i> Broderip and Sowerby	x	—	—
<i>Cardium consors</i> Sowerby	x	—	—
<i>Cardium senticosum</i> Sowerby	x	—	—
<i>Chama frondosa mexicana</i> Carpenter	x	—	—
<i>Chione californiensis</i> Broderip	x	—	—
<i>Chione undatella</i> Sowerby	x	—	cf.
<i>Codakia distinguenda</i> Tryon	x	—	—
<i>Divaricella lucasana</i> Dall and Ochsner	x	—	—
<i>Glycymeris</i> cf. <i>G. bimaculatus</i> Broderip	x	—	—
<i>Glycymeris delesserti</i> Reeve	x	—	—
<i>Megapitaria squalida</i> Sowerby	x	—	—
<i>Ostrea iridescens</i> Gray in Hanley	—	—	x
<i>Pecten circularis</i> Sowerby	—	x	—
<i>Pecten subnodosus</i> Sowerby	x	—	—
<i>Pecten vogdesi</i> Arnold	x	x	—
<i>Spondylus calcifer</i> Carpenter	x	—	—
<i>Spondylus princeps</i> Broderip	x	—	—
<i>Tagelus affinis</i> C. B. Adams	x	—	—
GASTROPODA			
<i>Astrea unguis</i> Wood	x	—	—
<i>Conus fergusoni</i> Sowerby	x	—	—
<i>Strombus galeatus</i> Swainson	x	—	—
<i>Turbo fluctuosus</i> Wood	x	—	—
<i>Turbo</i> sp.	—	—	x

<sup>a</sup> Identification courtesy of D. F. Squires.

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